

## REMARKS

In the Office Action dated February 7, 2006, claims 1-5 were rejected under 35 U.S.C. § 103(a) as being unpatentable over Japanese patent document JP 59156566 (Japanese '566) in view of U.S. Patent No. 4,971,134 to Kawaguchi et al. (Kawaguchi). Claims 6-7, 9-10, 12-14, 16, 18-21, 23, 25-26 and 47-70 were rejected under 35 U.S.C. § 103(a) as being unpatentable over the Japanese '566 document in view of Kawaguchi and in further view of U.S. Patent No. 5,915,452 to Conroy et al. (Conroy). Claims 15 and 22 were rejected under 35 U.S.C. § 103(a) as being unpatentable over Japanese '566 in view of Kawaguchi and in further view of Conroy and U.S. Patent No. 5,158,130 to Sahari. For the reasons outlined in detail below, it is respectfully submitted that the pending claims are in condition for allowance over all of the art of record.

### Independent Claim 1 and Dependent Claims 2-15

Independent claim 1 and dependent claims 2-5 were rejected over the combination of Japanese '566 and Kawaguchi. In this regard, it was stated that Japanese '566 teaches the claimed rapid cooling in a lost wax casting method for casting metal and comprises the use of simultaneous metal pouring and forming a partially solidified metal casting including a solidified metal shell by using controlled mist-like cooling water spraying on the mold containing molten metal for the purpose of forming a fine grain solidified metal shell and reducing defect for the casting. It was acknowledged that the Japanese '566 document fails to teach the removal of the mold. Therefore, reference was made to Kawaguchi. This document was said to teach the use of removing the mold after a solidified metal shell in the mold is formed and strong enough to contain the rest of the molten metal, but before the molten metal contained in the shell has been completely solidified for the purpose of reducing casting defects, such as thermal cracking, and minimizing adhesion between the casting product and the mold surface. It was then stated that it would have been obvious to one having ordinary skill in the art to provide the Japanese '566 document the use of removing mold as taught by Kawaguchi in order to further improve the quality of casting and reducing defects.

However, claim 1 recites a process for casting metals comprising the steps of providing a mold including an aggregate and removing a portion of the mold, including

at least a portion of the aggregate, wherein the step of removing at least a portion of the mold begins before the step of solidifying the molten metal has been completed. In this regard, it is noted that both the Japanese '566 document and Kawaguchi specifically disclose metal molds, not aggregate molds. Note Figure 5 of the Japanese '566 document wherein a metal cross section mold is shown. Figure 4 similarly shows a metal cross section. Also, in Kawaguchi, a metal mold is evident from numerous figures, such as Figures 3, 11, 12, 19, 24, 27-32, 35-38, 40-42, 47, 49, 50 and 52-54. In each figure, a metal cross section is shown. Moreover, Kawaguchi states that their mold 1 is formed from a copper chromium alloy (see column 10, lines 11-13; column 13, lines 8-9; column 16, lines 49-50; column 20, lines 1-2; or copper or copper alloy, see claims 3, 11, 15, 22 and 24). Such molds can be termed permanent molds.

Reference is also made to the enclosed Section 132 declaration of co-inventor, Professor John Campbell. Professor Campbell states that in the case of metal molds, such as those shown in Kawaguchi and the Japanese '566 patent document, including mold types referred to as "permanent molds", it is common for the mold to be open prior to the complete solidification of the casting. This is widely known, perfectly well-understood and practiced in permanent mold foundries and die casting shops all over the world. Therefore, the disclosure of such a mold in the Kawaguchi patent is not remarkable (see paragraph 6 of the Campbell declaration). Professor Campbell notes that the early opening of the mold is advantageous in order to achieve better productivity for a casting (see paragraph 7 of the Campbell declaration).

However, neither of the two newly applied references, namely, Japanese '566 and Kawaguchi, pertain to aggregate molds. As Professor Campbell states, he is unaware of any method for removing an aggregate mold while the casting is still at least partially molten. He notes that such a practice would probably be dangerous because the lower temperature gradient, as a result, the less severe cooling than in a metal mold, does not build up such an effective solidified shell as it does in a metal mold. In fact, for many alloys, particularly many non-ferrous base alloys that have high thermal conductivity, the temperature gradient in the casting is so low that liquid can remain at the casting surface until the final moments of solidification.

As he notes, it would thus be unthinkable for the mold to be removed prematurely, i.e., prior to complete solidification, especially if the fluid used to remove

the mold is water. As he notes, all casting education focuses on the extreme danger of mixing molten metal and water (see paragraph 9 of the Campbell declaration). Thus, neither of the applied references teach a process for the casting of metals that employ a mold including an aggregate, and in which at least a portion of the mold including at least a portion of the aggregate, is removed before the step of solidifying the molten metal has been completed, as recited in claim 1. As a result, claim 1 is patentable over the applied combination of Japanese '566 and Kawaguchi, as well as the remainder of the cited art.

Dependent claims 2-5 merely further patentably define the detailed subject matter of their parent claim. As such, these claims are also believed to be in condition for allowance over the art of record.

Dependent claims 6-7, 9-10 and 12-14 were rejected over Japanese '566 and Kawaguchi in further view of Conroy. It was stated the Japanese '566 in view of Kawaguchi fails to teach the use of water nozzles with a solvent. However, Conroy was said to teach the use of nozzles 20 and flow rate and pressure of fluid, including water and surfactant or solvent for the purpose of removing cores from castings. It was thereupon stated that it would have been obvious to one having ordinary skill in the art to provide Japanese '566 in view of Kawaguchi the use of water nozzles with a solvent as taught by Conroy in order to effectively cool the casting in the molten state and remove it from the casting mold.

However, Conroy does not provide those elements of claims 6-7, 9-10 and 12-14 which are clearly absent from Japanese '566 and Kawaguchi. More particularly, in Conroy, the teaching is to the removal of ceramic cores from turbine blade investment castings (see column 3, lines 24-26) after the castings have completely solidified. Note the use of fixtures or clamps 12 to hold the blade castings 10 in place. Moreover, attention is directed to claim 1 of Conroy which states in relevant part "apparatus for removing a ceramic core from a metallic casting SOLIDIFIED ABOUT said core." Similarly, independent claim 11 of Conroy recites "apparatus for removing a ceramic core from a metallic turbine blade or vane casting SOLIDIFIED ABOUT said core." Therefore, Conroy does not contemplate that one could remove at least a portion of a mold including an aggregate, especially a portion of the aggregate of the mold before the molten metal has completely solidified into a casting. Therefore, claims 6-7, 9-10

and 12-14 patentably define over the three-way combination of Japanese '566, Kawaguchi and Conroy.

Claim 15 was rejected under 35 U.S.C. § 103 as being unpatentable over Japanese '566, Kawaguchi, Conroy and Sahari. In this connection, it was noted that Japanese '566, Kawaguchi and Conroy together fail to teach the reuse of a binder. Sahari was said to teach the reuse of a binder agent. It was then stated it would have been obvious to one having ordinary skill in the art to provide Japanese '566 in view of Kawaguchi and Conroy the reuse of binders taught by Sahari in order to effectively and economically perform casting and molding.

However, Sahari also does not provide a process for the casting of metals wherein at least a portion of a mold including an aggregate is removed, including at least a portion of the aggregate, wherein the step of removing begins before the step of solidifying the molten metal has been completed. Sahari particularly teaches that only after the cast metal or metal alloy has crystallized, can the mold and any core be disassembled (see column 6, lines 11-12). Thus, none of the four applied references contemplate that one could provide a mold including an aggregate and remove at least a portion of the mold, including at least a portion of the aggregate, before the molten metal in the mold has completely solidified into a casting. As such, it is respectfully submitted that claim 15 similarly patentably defines over the applied four way combination, as well as the remainder of the cited art.

#### Independent Claim 16 and Dependent Claims 18-23, 25 and 26

Independent claims 16 was rejected over a three way combination of Japanese '566, Kawaguchi and Conroy. It was stated that Japanese '566 in view of Kawaguchi fails to teach the use of water nozzles with a solvent. However, Conroy was said to teach the use of nozzles 20 and flow rate and pressure of fluid including water and surfactant or solvent for the purpose of removing cores from castings.

Claim 16 recites a process for reducing the cooling time of metal that has been cast, including decomposing at least a portion of the mold with a solvent and cooling the molten metal with the solvent wherein the step of spraying commences before the molten metal has completely solidified. As to the applied three-way combination of Japanese '566, Kawaguchi and Conroy, it is respectfully submitted that none of these

three references, in any combination, teach the decomposing of at least a portion of the mold with a solvent, wherein the step of spraying the solvent begins before the molten metal has completely solidified. Obviously, with the metal molds in Japanese '566 and Kawaguchi, there is no decomposition that takes place at all. While there is a dissolving of a core shown in Conroy, the core is dissolved only after the molten metal has completely solidified, as pointed out above.

Thus, none of these three references in any combination render unpatentable a process for reducing the cooling time of a metal that has been cast, including decomposing at least a portion of the mold with a solvent and cooling the molten metal with a solvent wherein the step of spraying commences before the molten metal has completely solidified. In Japanese '566, there is no removal of the mold, as is admitted in paragraph 3 of the Office Action. While there is a removal of the mold in Kawaguchi, that removal is of a metal mold. As to Conroy, the core is dissolved only after the molten metal has completely solidified. There is no decomposition of at least a portion of the mold shown in any of the three applied references, which commences before the molten metal has completely solidified. Again, it is noted that the only reference which teaches decomposing the mold, namely, Conroy, the teaching is to the removal of ceramic cores only after the castings have completely solidified (see claims 1 and 11 of Conroy). Thus, it is respectfully submitted that claim 16 also patentably defines over the applied three-way combination of references, as well as the remainder of the cited art.

Dependent claims 18-21, 23, 25 and 26 were also rejected over the three-way combination of Japanese '566, Kawaguchi and Conroy. Since these claims merely further patentably define the detailed subject matter of their parent claim, or each other, they too are believed to be in condition for allowance over the art of record, for the reasons advanced above.

Dependent claim 22 was rejected over the four-way combination of Japanese '566, Kawaguchi, Conroy and Sahari. However, there is no teaching or disclosure in the applied four-way combination of decomposing at least a portion of the mold with the solvent and cooling the molten metal with the solvent, wherein the step of spraying commences before the molten metal has completely solidified. As noted previously, in Sahari, the mold and any core is only disassembled after the cast metal or metal alloy

has crystallized (see column 6, lines 11-12). Thus, in the applied four-way combination, there is no decomposition of the mold with a solvent wherein the step of spraying the solvent commences before the molten metal has completely solidified. Therefore, claim 22 also patentably defines over the applied four-way combination of references, or in the remainder of the prior art.

#### Independent Claim 47 and Dependent Claims 48-53

Independent claim 47 was similarly rejected over the three-way combination of Japanese '566, Kawaguchi and Conroy. Claim 47 recites a process for casting an aluminum metal including decomposing at least a portion of the mold at an elevated temperature with a solvent including water, wherein the step of decomposing at least a portion of the mold begins before the molten aluminum metal has completely solidified into a casting.

As noted above, there is no teaching or disclosure in any of the applied three-way combination of decomposing at least a portion of the mold, in which a molten aluminum metal has been poured, with a solvent including water, wherein the step of decomposing begins before the molten aluminum metal has completely solidified into a casting. As noted in Professor Campbell's declaration, no such decomposition of a mold is shown in any of the patent documents to Kawaguchi, Japanese '566, Sahari or Conroy. As he further states, he is unaware of any method in which an aggregate mold is removed prior to complete solidification of the molten metal, especially when the removal is conducted with water. Such an action would be unthinkable dangerous and such danger is fundamental to the thinking of foundry personnel throughout the world (see paragraph 9 of Professor Campbell's declaration). Thus, it is respectfully submitted that claim 47 patentably defines over the applied three-way combination of references.

Dependent claims 48-53 merely further patentably define the detailed subject matter of their parent claim, or each other. As such, these claims are also believed to be in condition for allowance over the applied three-way combination of references, as well as the remainder of the cited art.

#### Independent Claim 54 and Dependent Claims 55-61

Independent claim 54 was rejected over the three-way combination of Japanese '566, Kawaguchi and Conroy. However, claim 54 recites a process for reducing the cooling time of a metal that has been cast including percolating a solvent including water through the mold to the cast metal; forming a relatively solid skin on the cast metal while an interior thereof remains molten; and, subsequently, contacting the relatively solid skin of the cast metal with the solvent. There is no teaching or disclosure in the applied three-way combination of the method recited in claim 54.

More particularly, while Kawaguchi may teach a removal of a metal mold when the surface layer of the casting has been converted into a shell-like solidified layer, there is no teaching or disclosure of contacting the relatively solid skin of the cast metal with a solvent which is percolated through the mold. Since Kawaguchi teaches a metal mold, there cannot be a percolation of a solvent, including water, through the mold. Japanese '566 similarly teaches a metal mold and cannot teach a method for percolating a solvent, including water, through the mold to contact a relatively solid skin of cast metal with the solvent. Conroy, on the other hand, teaches that the casting has to be completely solidified before there is a removal of the ceramic core from the casting via a fluid spray. Thus, none of the applied three references in any combination teach a process for reducing the cooling time of the metal by percolating a solvent, including water, through a mold to the cast metal; forming a relatively solid skin on the cast metal while an interior thereof remains molten; and, subsequently, contacting the relatively solid skin of the cast metal with the solvent, as recited in claim 54. Accordingly, claim 54 also patentably defines over the applied three-way combination, as well as the remainder of the cited art.

Dependent claims 55-61 merely further patentably define the detailed subject matter of their parent claim or each other. As such, these claims are also believed to be in condition for allowance over the applied three-way combination of references, as well as the remainder of the art of record.

#### Independent Claim 62 and Dependent Claims 63-70

Independent claim 62 was similarly rejected over the three-way combination of Japanese '566, Kawaguchi and Conroy. Claim 62 now recites a method of removing a

mold including an aggregate from a casting which is being formed therein, comprising directing a fluid stream at the mold when the casting is partially solidified and dislodging at least a portion of the aggregate of the mold from the casting. As noted in paragraph 14 of Professor Campbell's declaration, this method is not shown in any of the patent documents to Kawaguchi, Japanese '566, Sahari or Conroy. Japanese '566 and Kawaguchi pertain to metal molds. Conroy pertains to ceramic cores. In Conroy, there is disclosed an apparatus for removing a ceramic core from a metallic casting which has solidified about the core (see claims 1 and 11 of Conroy) rather than dislodging at least a portion of the aggregate of a mold from a casting when the casting is partially solidified, as recited in claim 62. While Sahari does pertain to a granular molding material and a binder, in Sahari, it is explicitly taught that the cast metal or metal alloy is crystallized before there is any removal or disassembly of the mold and any core (see column 6, lines 11-12). Therefore, none of these four references in any combination render unpatentable the subject matter recited in claim 62. Moreover, this claim is also in patentable condition over the remainder of the recited art.

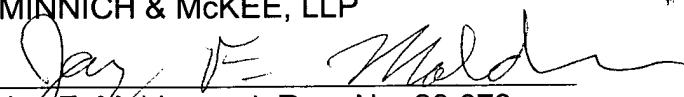
Dependent claims 63-70 merely further patentably define the detailed subject matter of their parent claim or each other. As such, these claims are also believed to be in condition for allowance over the art of record.

In view of the foregoing, it is respectfully submitted that all of the pending claims are in condition for allowance over the art of record.

Respectfully submitted,

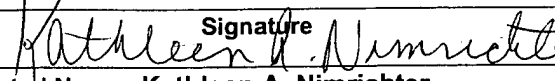
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